MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015 / 2016

ECE3286 – DIGITAL IMAGE AND VIDEO COMPRESSION
(ME)

12 MARCH 2016
2.30 p.m. - 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **FIVE** printed pages with **FOUR** questions.

2. Answer **ALL** questions.

3. Write your answers in the Answer Booklet.

Question 1

(a) Briefly discuss the need for image and video compression. Describe the terms: lossless compression and lossy compression.

[6 marks]

(b) Consider a high definition television (HD) with a spatial resolution of 1920 x 1080 at 30 frames per second. Suppose that each color components of a pixel is encoded with 8 bits. Compute the total number of bits needed to store 1.5-hour movie if:

(i) RGB color format is used.

[3 marks]

(ii) YC_bC_r color format with 4:2:2 sampling is used.

[3 marks]

(iii) YC_bC_r color format with 4:2:0 sampling is used.

[3 marks]

Based on your answers above, describe the differences between RGB and YC_bC_r color formats.

[3 marks]

(c) The sensitivity of the human visual system (HVS) depends on spatial frequency and temporal frequency. Visual sensitivity is highest at some intermediate spatial and temporal frequencies, and diminishes at some cut-off frequencies.

(i) In your own words, briefly explain the following terms: spatial frequency and temporal frequency.

[4 marks]

(ii) Why is it important to determine the 'cut-off frequency' for HVS frequency response?

[3 marks]

Continued ...

Question 2

(a) Draw a block diagram of the encoder of a typical transform coding system. Explain in your own words, the function of each block in the diagram.

[8 marks]

(b) The goal of the transformation process is to decorrelate the pixels in image and video-frame.

   (i) In your opinion, why decorrelation is important in a typical image and video compression system?

[2 marks]

   (ii) Name **TWO (2)** transformation methods that are suitable for image and video compression.

[2 marks]

(c)

Source Symbol	Probability	Huffman Code
S_1	0.3	00
S_2	0.1	101
S_3	0.2	11
S_4	0.05	1001
S_5	0.1	1000
S_6	0.25	01

Table Q2

Table Q2 shows the occurrence probabilities and the Huffman code set for six source symbols. Compute:

   (i) the entropy of the source.

[3 marks]

   (ii) the average number of bits per symbol using Huffman code.

[3 marks]

   (iii) the redundancy of Huffman Code

[2 marks]

   (iv) the minimum number of bits required assuming fixed-length codewords.

[2 marks]

Based on your answers in parts (i)-(iv) above, comment on the performance of Huffman code.

[3 marks]

Question 3

(a) JPEG and JPEG2000 are two popular standards for image compression.

    (i)   Discuss **TWO (2)** types of redundancy that are exploited by JPEG and JPEG2000.

                     [4 marks]

    (ii)   Blocking artifact sometimes could be found in some JPEG images. Explain what causes the blocking artifact and suggest **TWO (2)** methods to reduce this effect.

                     [4 marks]

    (iii)   JPEG2000 offers better image quality than JPEG at the same compression ratio. Describe another **THREE (3)** advantages of using JPEG2000.
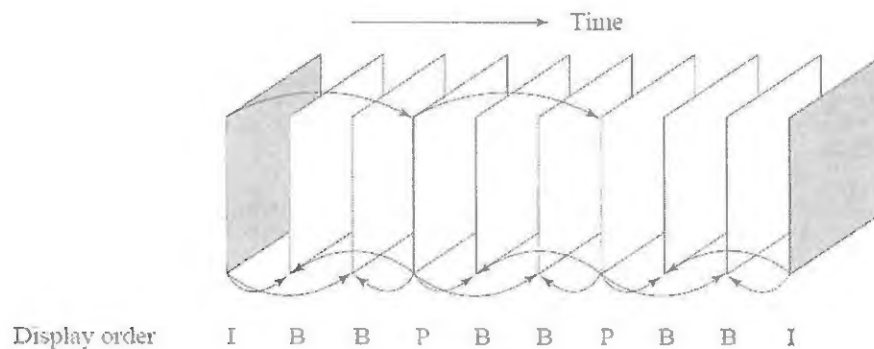
                     [6 marks]

(b)

Figure Q3

Figure Q3 shows the display order of frames sequence.

    (i)   Briefly describe how I-, P- and B-frames are constructed in a typical video coding system.

                     [6 marks]

    (ii)   Determine the coding and transmission order for the above frames sequence. Justify your answer.

                     [5 marks]

Question 4

(a) H.261 and H.263 are among popular video coding standards developed by ITU-T.

  (i)   What are the main applications of H.261 and H.263 coding standards?

[2 marks]

  (ii)   In your own words, discuss the differences between these two coding standards.

[4 marks]

(b) Distinguish between Internet Protocol Television (IPTV) and Internet Video.

[6 marks]

(c)

Figure Q4

Figure Q4 shows a video sequence of a golf player. The video resolution is 640 x 480 and the frame rate is 30 fps. An uncompressed digital video usually contains a large amount of temporal redundancy.

  (i)   In your opinion, why frame differencing technique is not suitable to compress the above video sequence.

[2 marks]

  (ii)   Discuss how motion estimation and motion compensation can be used for the above video sequence to achieve better compression.

[5 marks]

  (iii)   Compute the total operations per second of motion vector using Mean Absolute Difference (MAD) method. The search range, P, is 15 and the macroblock size, N, is 16.

[6 marks]

End of paper